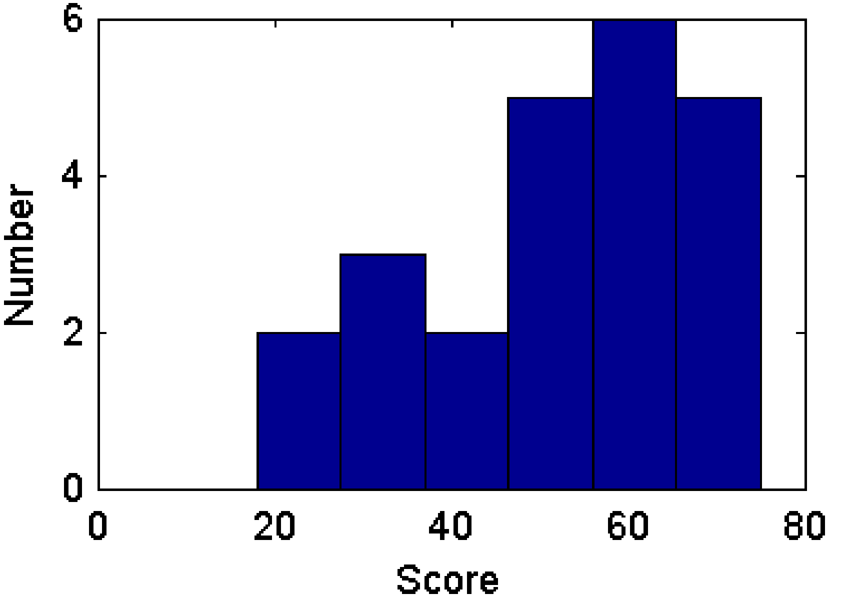
Physics 3210

Week 13 clicker questions

Exam 3 scores
Median 52
SD 16



We wish to determine the kinetic energy $T=\frac{1}{2}\boldsymbol{\omega}\bullet I\boldsymbol{\omega}$, where $\boldsymbol{\omega}$ is the angular velocity and I is the inertia tensor.
Which frame should we use when doing the calculation?

A. The body frame
B. The space frame
C. Some other frame

We determined the kinetic energy $T=\frac{1}{2}\boldsymbol{\omega}\cdot I\boldsymbol{\omega}$ in the body frame. How does this compare to the kinetic energy in the space frame?

A. The kinetic energy in the space frame is less than the kinetic energy in the body frame.
B. The kinetic energy in the space frame is the same as the kinetic energy in the body frame.
C. The kinetic energy in the space frame is greater than the kinetic energy in the body frame.

Physics 3210

Wednesday clicker questions

We found the Lagrangian of a symmetric top in a gravitational field:

$$\mathcal{L} = \frac{1}{2}\left[I_1\left(\dot{\psi} + \dot{\phi}\cos\theta\right)^2 + I_2\left(\dot{\phi}^2\sin^2\theta + \dot{\theta}^2\right)\right] - mgR\cos\theta$$

Which of the following quantities are conserved?

I. The total energy.

II. The generalized momentum associated with θ.

III. The generalized momentum associated with ψ.

IV. The generalized momentum associated with φ.

A. I only.

B. I and II.

C. I, II, and III.

D. I, III, and IV.

E. I, II, III, and IV.

We found that the total energy of a symmetric top in a gravitational field can be written:

$$E - \frac{L_1^2}{2I_1} = \frac{1}{2} I_2 \dot{\theta}^2 + mgR\cos\theta + \frac{\left(L_z - L_1\cos\theta\right)^2}{2I_2 \sin^2\theta}$$

What motion does this equation describe?

A. One-dimensional motion in θ.

B. The coupling between θ and φ motion.

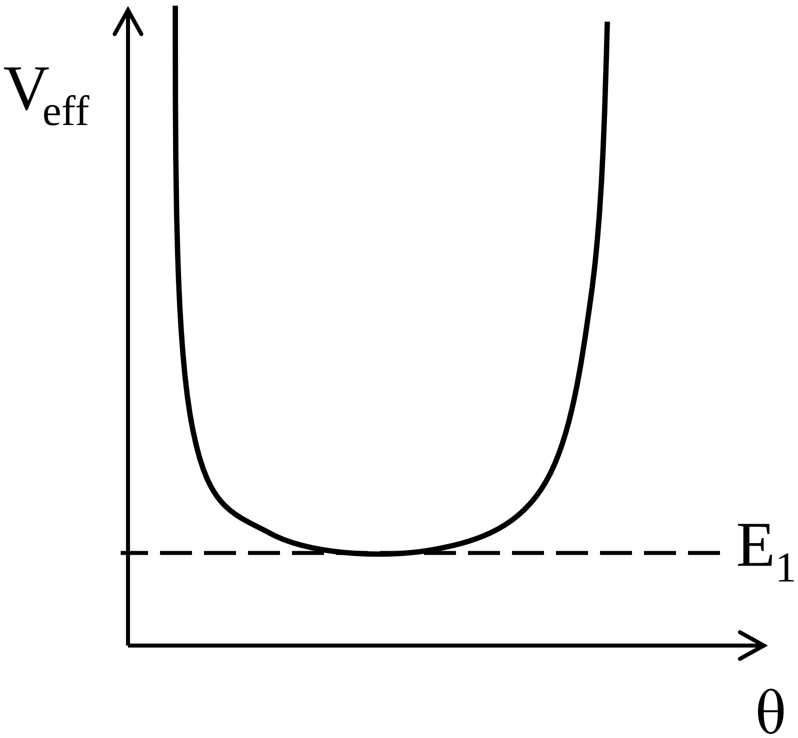
C. The coupling between θ and ψ motion.

D. The coupling between θ, φ, and ψ motion.

E. None of the above.

A symmetric top has total effective energy E_1.

What type of motion does this top undergo?



A. The top is stationary.

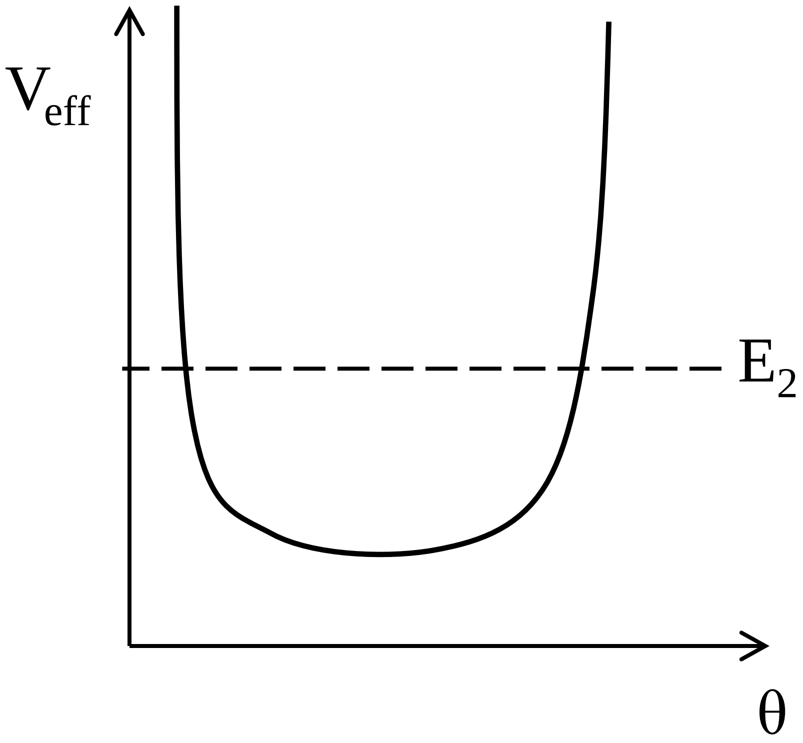
B. The top undergoes constant precession about the vertical axis.

C. The top undergoes precession about the vertical axis combined with nutation.

D. It cannot be determined from the information given.

A symmetric top has total effective energy E_2.

What type of motion does this top undergo?



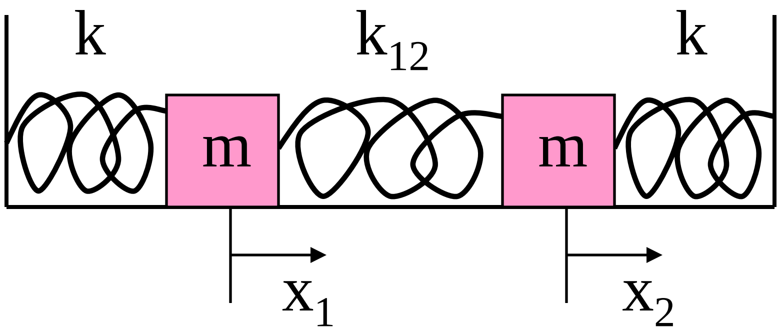
A. The top is stationary.

B. The top undergoes constant precession about the vertical axis.

C. The top undergoes precession about the vertical axis combined with nutation.

D. It cannot be determined from the information given.

A system of two coupled harmonic oscillators has spring constants k (left spring), k_{12} (middle spring), and k (right spring). The displacements of the blocks are measured from equilibrium.



What are the forces on the blocks?

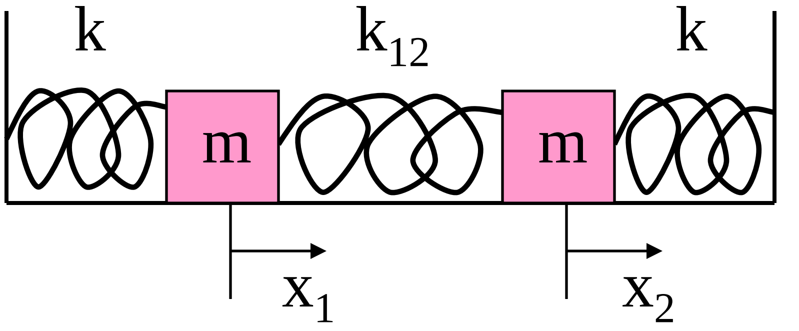
A.
$$F_1 = -kx_1 - k_{12}(x_1 - x_2)$$
$$F_2 = -kx_2 - k_{12}(x_2 - x_1)$$

B.
$$F_1 = -kx_1 - k_{12}(x_2 - x_1)$$
$$F_2 = -kx_2 - k_{12}(x_1 - x_2)$$

C.
$$F_1 = -kx_2 - k_{12}(x_1 - x_2)$$
$$F_2 = -kx_1 - k_{12}(x_2 - x_1)$$

D.
$$F_1 = -k_{12}x_1 - k(x_2 - x_1)$$
$$F_2 = -k_{12}x_2 - k(x_1 - x_2)$$

For the system of two coupled harmonic oscillators, an oscillatory solution is possible if the amplitudes satisfy



$$\begin{bmatrix} k+k_{12} & -k_{12} \\ -k_{12} & k+k_{12} \end{bmatrix} \begin{bmatrix} B_1 \\ B_2 \end{bmatrix} = m\omega^2 \begin{bmatrix} B_1 \\ B_2 \end{bmatrix}$$

What type of equation is this?

A. A system of differential equations.

B. A polynomial equation.

C. An eigenvalue equation.

D. A system of nonlinear equations.

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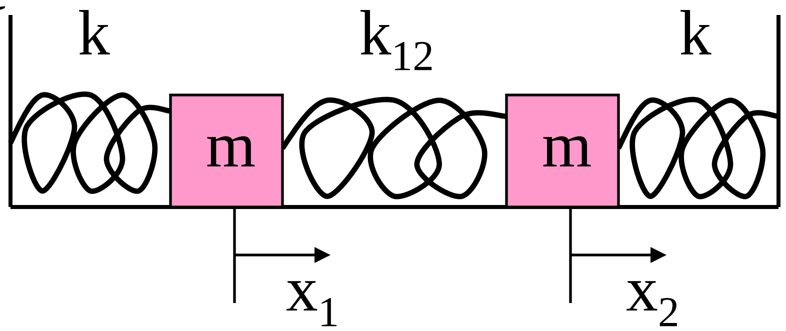
Friday clicker questions

For the system of two coupled harmonic oscillators, the eigenfrequencies are



$$\omega_1 = \sqrt{\frac{k+2k_{12}}{m}}, \quad \omega_2 = \sqrt{\frac{k}{m}}$$

What types of motion correspond to oscillations with the two eigenfrequencies?

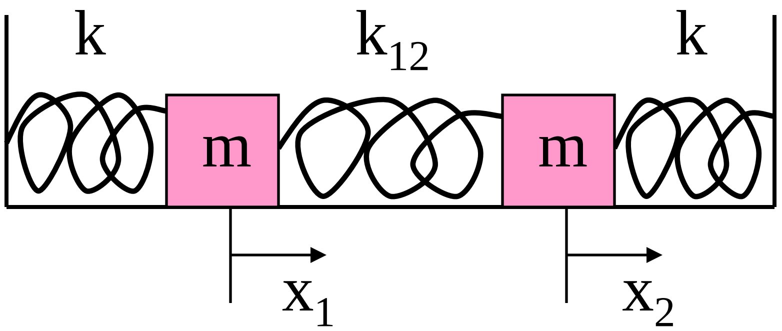
A. The blocks move with the same frequency. For frequency ω_1: the two blocks are in phase; for frequency ω_2, the two blocks are exactly out of phase.

B. The blocks move with the same frequency. For frequency ω_1: the two blocks are exactly out of phase; for frequency ω_2, the two blocks are in phase.

C. The blocks move with different frequencies.

D. None of the above.

A system of two coupled harmonic oscillators has spring constants k (left spring), k_{12} (middle spring), and k (right spring).
If block 1 oscillates while block 2 is held fixed, what is the frequency of oscillations?



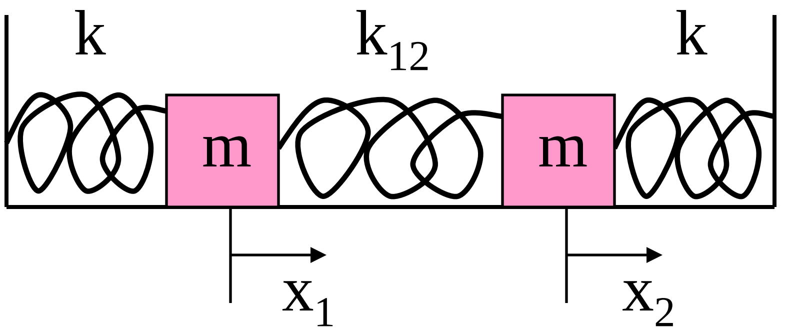
A. $\omega_0 = \sqrt{\dfrac{k}{m}}$

B. $\omega_0 = \sqrt{\dfrac{k + k_{12}}{m}}$

C. $\omega_0 = \sqrt{\dfrac{k + 2k_{12}}{m}}$

D. $\omega_0 = \sqrt{\dfrac{k - k_{12}}{m}}$

A system of two coupled harmonic oscillators has spring constants k (left spring), k_{12} (middle spring), and k (right spring). The displacements of the blocks are measured from equilibrium.



How do the eigenfrequencies compare to the uncoupled frequency $\omega_0 = \sqrt{\frac{k + k_{12}}{m}}$?

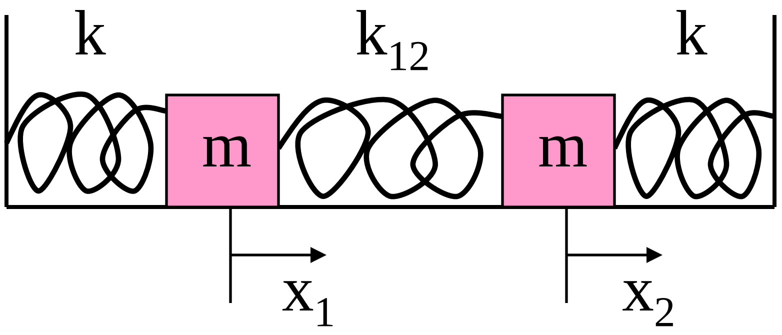
A. $\omega_0 < \omega_1 < \omega_2$

B. $\omega_1 < \omega_0 < \omega_2$

C. $\omega_1 < \omega_2 < \omega_0$

D. $\omega_2 < \omega_0 < \omega_1$

A system of two coupled harmonic oscillators has spring constants k (left spring), k_{12} (middle spring), and k (right spring). The displacements of the blocks are measured from equilibrium.



If the coupling is weak ($k_{12} << k$), what is an approximate expression for the frequency $\omega_0 = \sqrt{\frac{k + k_{12}}{m}}$?

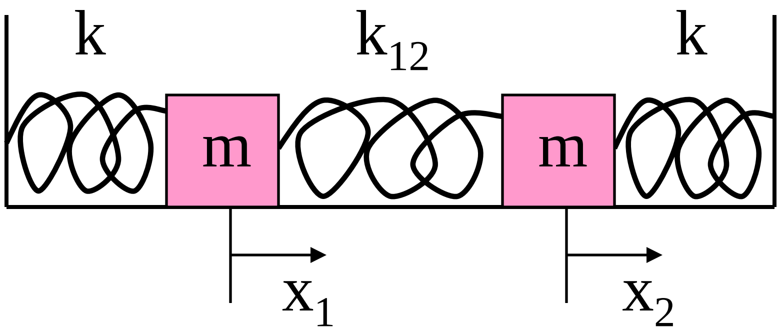
A. $\omega_0 \approx \sqrt{\frac{k}{m}}\left(1 + \frac{k_{12}}{k}\right)$

B. $\omega_0 \approx \sqrt{\frac{k}{m}}\left(1 + \frac{k_{12}}{2k}\right)$

C. $\omega_0 \approx \sqrt{\frac{k}{m}}\left(1 - \frac{k_{12}}{k}\right)$

D. $\omega_0 \approx \sqrt{\frac{k}{m}}\left(1 - \frac{k_{12}}{2k}\right)$

A system of two coupled harmonic oscillators has weak coupling (k_{12}<<k), and block 1 is displaced and released from rest. We found that



$$x_1(t) = D\cos(\varepsilon\omega_0 t)\cos(\omega_0 t)$$

$$x_2(t) = D\sin(\varepsilon\omega_0 t)\sin(\omega_0 t)$$

What type of motion do these equations describe?

A. Harmonic oscillation of both blocks at a single frequency.

B. Fast oscillation of block 1 and slow oscillation of block 2.

C. Fast oscillation of block 2 and slow oscillation of block 1.

D. Alternating fast and slow oscillations of the two blocks.

E. Oscillation with beats: a fast oscillation modulated by a slow oscillation.